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Simultaneous Position and Impedance Control for Myoelectric Interfaces

Advances in human-robot interaction through myoelectric control has the potential to significantly improve prosthetics and artificial limbs. For these applications, humans need compliant robots to safely interact in dynamic environments associated with daily activities. Surface electromyography (sEMG) has been identified as a candidate for naturally controlling such robots as it non-invasively measures limb motion intent and correlates with joint stiffness during co-contractions. However, state-of-the-art myoelectric interfaces have struggled to achieve reliable simultaneous control of motion and stiffness. Additionally, electromyography-based impedance controllers have failed to extend beyond a single degree-of-freedom (DOF). As demands in myoelectric interfaces trend toward simultaneous and proportional control of compliant robots, decoupling muscle signals into independent stiffness and position controls is essential.

Researchers at Arizona State University have developed a myoelectric control framework that allows for multi-directional impedance and position control in myoelectric interfaces. The control framework allows users to control motion and stiffness independently, proportionally, and/or simultaneously for multiple degrees of freedom. Furthermore, the framework offers enhanced functionality via directional impedance without sacrificing the stability of motion controls nor requiring additional inputs specifically for stiffness outputs. The control framework provides a natural interface for enhancing the capabilities of compliant human-robot interaction. Thus, the invention increases the viability of myoelectric interfaces in applications requiring compliant robotics, particularly for prosthetics and exoskeletons.

Potential Applications

- Prosthetics and artificial limbs
- Exoskeletons
- Human—robot interactions
- Myoelectric interfaces

Benefits and Advantages

- Increased Control - Offers impedance control in multiple degrees of freedom, and provides both stiffness and motion control in multiple degrees of freedom.
- Improved Performance - Impedance control allows for safe interactions with uncertain environments, enhancing both utility and viability.
- Intuitive - The stiffness transformation is designed such that outputs are correlated with muscle intensity, providing an intuitive stiffness control similar to how humans naturally adjust intensity and direction of joint stiffness.

- Multi-functional - Provides both stiffness and motion control of a device with one or more DOFs, using the same set of inputs, whereas other techniques only offer motion or stiffness exclusively for a given set of inputs.

For more information about the inventor(s) and their research, please see

Dr. Panagiotis Artemiadis's directory webpage